Mapping and control vs. Instrumental interaction

Nicolas Castagné

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Nicolas Castagne [ACROE&INPG]

Contributors: Olivier Tache [ACROE&INPG], Marcello Wanderley [SPCL]

For a human-computer interactive system, implementing the paradigms of control/mapping [→ Mapping] can correspond, in some cases, to fundamental drawbacks. The current item provides an illustration of this observation by examining the typical case of today's mapping-based digital musical instruments [→ Mapping, in digital musical instruments].

In traditional musical instruments (i.e. acoustic instruments, such as the violin or the clarinet), energy within the sounds originates in the player himself ([→ Interface, ergotic]; see also the figure in the related external document). The sound then results from a physical gesture interaction between the instrument and the player, featuring an energetic coupling. The energetic coupling, and the tactilo-proprio-kinesthetic gesture feedback [→ Gestural channel] are intimately correlated with the sound, influence sound quality and diversity, and readability of gestures within the sound. They ensure a high level of sensitivity and expressivity.

Contemporary digital musical instruments modified fundamentally this situation (see also the figure 2 in the related document). The performer's gestures are encoded by a gesture controller (e.g. keyboard, pad…) through a unidirectional gesture signal. Often, this signal is not sampled, but event-based, for example by using the MIDI protocol [→ Gesture and motion (encoding of)]. The gesture signal then passes through the mapping stage, and is finally input, often with a noticeable latency, into the synthesizer. The performer receives a primary gesture feedback due to the passive physics and ergonomy of the gesture controller, and a synthesized sound feedback through sound transducers, also provided to the audience.

The quality / readability of the control depends especially on the chosen mapping strategy. However, in any case, the sound is not originated in the gesture of the performer; it is built by a "distant" computational process which is controlled or triggered by the performer. The energy in the sound, and the microstructure of the sound, can hardly be intimatelly correlated with gesture. Though one can say that the system is interactive, it does not offer a strong multisensory instrumental interaction.

Indeed, one can note that digital musical instruments conforming to this structure have rarely succeeded in offering as interesting expressive possibilities as those of acoustic instruments, such as the violin, or the electric guitar, for example [Wanderley, 1999]. This is particularly clear when considering the case of sustained sound instruments, such as strings or winds. This is not due to the sound models that are now very accurate. Indeed, now that this mainstream approach has led to a high level of complexity and technological efficiency, there must be some fundamental reasons that explain this still-remaining lack of expressivity.

The framework of enactive interfaces emphasizes the unity of human perception, and as a vis-à-vis the need of a particularly high and thin correlation between the gesture of the user and the various multi-sensory stimuli generated in feedback (sound+gesture feedback in the case of musical instruments). Indeed, the mapping of gesture to control various exhogeneous parameters of a signal-based synthesis model implies that there is an ontological rupture between the two mapped domains. This ontological rupture risks to reduce, and sometimes to break, the close interaction needed between the various stimuli generated.

Facing this problem, an alternative is using physical simulation along with force feedback transducers, altogether allowing to obtain an ergotic interface. Potentially [Castagne et al, 2004], a physical simulation is able to generate all the sensory stimuli in response to gesture in one shot [→ Physically-based modelling techniques for multisensory simulation]. In that case, there is no more need of a complex mapping strategy introducing an ontological cut. Gesture signals are directly meaningful inside the physical model. As for them, force feedback interfaces potentially make it possible to simulate an energetic interaction, by allowing a coupling of the dual force and position variables – see the Figure 3 in the related document.

A couple of experiments [Nichols, 2002] [Florens, 2002] nowadays foresee the relevance of such a structure. In Florens' work, the string was considered as a fully linear system, and the bow/string interaction implemented a simple non-linear viscosity curve. Conversely to the simplicity of the string model, the installation implemented a high quality ERGOS haptic device [Cadoz et al, 1990], [Florens et al, 2004]. As a result, most of the relevant sound cues could be obtained: full excitation of the string on its first mode, full harmonic, creaking, etc. Hence, the use of a high-quality force feedback system and of physically-based modelling is at least as important (and probably more important) than the accuracy of the computed model.

Hence, ergotic interfaces may correspond with a fundamental evolution in our digital musical instrument, a paradigm shift. As an alternative to the principles of control, mapping and interactivity, they promote the concept of multisensory instrumental interaction interaction [→ Instrumental interaction] with a digital artefact through an energetically coherent bidirectional gesture coupling, allowing to experience again, with digital systems, the situation in which "the hand makes the sound".

References

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